Durability-focused optimization of an engine suspension

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Background & Objectives

In the development phase of a new car project the behavior of the engine suspension is simulated and studied with respect to several attributes (NVH, driveability, ride, durability, etc.). For CAE Durability at Volvo Car Corporation, an important part of this simulation phase is to evaluate peak loads and fatigue loads for a series of defined driving events. Simulations of the full vehicle including powertrain and engine suspension are conducted using ADAMS/Car.

The characteristics of the components need to be chosen appropriately in order to optimize durability. The goal of the Master thesis was to develop an optimization tool for this purpose.

Method

An autonomous simulation interface was created, connecting the existing runscripts and processes by means of a central Excel setup file and a comprehensive MATLAB program. This allowed incorporating the road load simulations into an optimization process. After investigation of several thinkable algorithms a custom hybrid Genetic Algorithm/Pattern Search optimization structure was implemented in MATLAB. Furthermore, a new concept for rubber fatigue life prediction was introduced, using maximum principal strain as an equivalence parameter and signal processing methods known from metal damage calculations.

Hybrid optimization structure

In order to minimize the number of necessary function evaluations and to combine the strengths of local and global search, a hybrid Genetic Algorithm/Pattern Search was programmed. While the Genetic Algorithm searches the entire variable space to avoid local minima, the Pattern Search continually attempts to fine-tune the best individuals.

Rubber fatigue life prediction

Fatigue life estimates of rubber components have so far been done using the same concept as for metal components. However, this does not capture the hyper-elastic characteristics of rubber materials. Rubber fatigue life prediction is a complex and highly active field of research. The method proposed in this thesis is based on maximum principal strain as fatigue parameter and the Palmgren-Miner linear damage theory. First validations suggest promising correlation with experiments.

Keywords

Engine rubber mount; Full vehicle simulation; Optimization; Genetic Algorithm; Pattern Search; Rubber fatigue; Fatigue life prediction; Linear damage theory

Acknowledgements

Rickard Petersson
Annika Lundberg
Prof. Thomas Gmür